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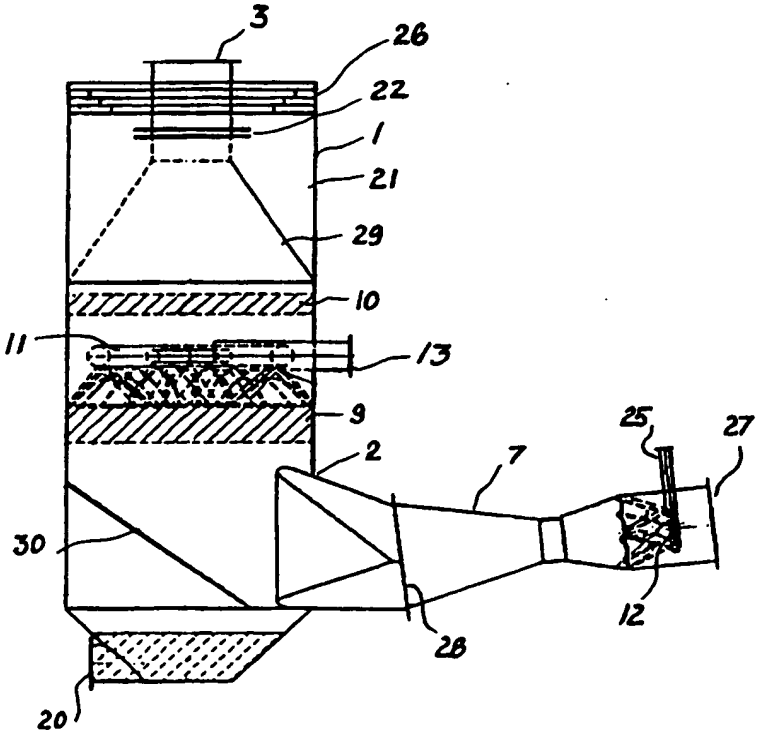
(54) Title: APPARATUS FOR REDUCING CONTAMINANTS IN A PULSATING EXHAUST GAS

(57) Abstract

An apparatus for reducing contaminants in a pulsating exhaust gas, particularly diesel exhaust, on board ships, which apparatus comprises a wet scrubber, which includes a chamber in a housing having a gas inlet and a gas outlet, a fluid injection device and gas filters in the chamber, and a venturi nozzle, having a nozzle inlet and a nozzle outlet, connected to the gas inlet of the scrubber by means of its nozzle outlet.



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APPARATUS FOR REDUCING CONTAMINANTS IN A PULSATING EXHAUST GAS

The invention relates to an apparatus for reducing contaminants in a pulsating exhaust gas, particularly diesel exhaust, on board ships which apparatus comprises a wet scrubber which includes a chamber in a housing having a gas inlet and a gas outlet, a fluid injection device and gas filters in the chamber.

The invention has been developed in particular for use on board diesel-engine powered ships where oil having a high sulphur content is used as fuel.

Environmental protection requirements represent a major challenge both nationally and internationally. A need is seen not only to limit discharge from ships into the sea, but also to reduce air pollution from ships. Exhaust gas emissions from marine engines pollute due to the fact that they contain *inter alia* oxides of sulphur and nitrogen (SOX and NOX) from combustion - producing acid rain and causing breathing difficulties; carbon dioxide from combustion - contributing to global warming; carbon monoxides from incomplete combustion - being a chemical poison; hydrocarbons resulting from incomplete combustion and fuel vapour - producing so-called smog; particles which are due to incomplete combustion and ash - producing smoke and potential health problems; and noise.

Noise, and in particular pulsation noise, may be suppressed by using various types of noise suppressors (silencers). Noise suppressors may take various forms, one embodiment being the so-called reactive noise suppressor, which is a pulsation noise suppressor wherein a venturi nozzle is used to smooth out the pulsation shocks.

There are known gas scrubbers wherein gas in scrubbed or purified by being conducted in countercurrent to a water spray and through wet filters, so as to wash out SOX, soot and other particles. It is known to employ such wet scrubbers on board ships for the treatment of a portion of the combustion exhaust gas in order to produce inert gas which is used for release of gas from tanks on board.

One of the objects of the invention is to provide an apparatus whereby the need for reduction of contaminants and noise in a pulsating exhaust gas, particularly diesel exhaust, on board ships may be met.

A particular object of the invention is to make feasible an apparatus for reducing contaminants and noise in a pulsating gas, particularly diesel exhaust, on board ships in a compact and space-saving manner.

It is also a specific object of the invention to endeavour to ensure that the exhaust gas exiting a wet scrubber is dry.

According to the invention an apparatus is therefore proposed for reducing contaminants in a pulsating exhaust gas, particularly diesel exhaust, on board ships, which apparatus comprises a wet scrubber, which includes a chamber in a housing having a gas inlet and a gas outlet, a fluid injection device and gas filters in the chamber, which apparatus is characterised in that a venturi nozzle, having a nozzle inlet and a nozzle outlet, is connected by means of its nozzle outlet to the gas inlet of the wet scrubber.

Particles in the gas will be separated out in the venturi nozzle.

It is particularly advantageous if a fluid injection device is arranged in the nozzle inlet.

The injection of fluid into the venturi nozzle contributes to the washout of particles. Additional particle washout and sulphur absorption takes place in the subsequent wet scrubber in the direction of the gas flow. The gas is freed of a portion of moisture in the filters (demisting).

The fluid injection device in the nozzle inlet may advantageously be adapted for the injection of fluid in the direction of the nozzle outlet.

It is especially advantageous if the fluid injection device in the nozzle inlet is a high-pressure sea water device.

The fluid injection device arranged in the wet scrubber housing may advantageously be a low-pressure sea water device.

In one advantageous embodiment, the wet scrubber is a vertical scrubber having a bottom gas inlet, the venturi nozzle connected thereto being substantially horizontal.

The substantially horizontal venturi nozzle may advantageously open sideways into the bottom, likewise sideways-oriented gas inlet of the wet scrubber.

It is especially advantageous if the wet scrubber gas outlet is connected to one or more adjacent resonator chambers. In this connection, at least one resonator chamber may be in the form of a Helmholtz resonator chamber. At least one resonator chamber may advantageously be in the form of a Lambda-1/4 resonator.

Around the gas outlet of the wet scrubber there may be arranged successively a Helmholtz resonator and a Lambda-1/4 resonator.

In a practical embodiment, the chamber in the wet scrubber housing may have a conical upward tapering portion which forms a wall in a resonator chamber.

In another especially advantageous embodiment, the venturi nozzle may form a part of a reactive noise suppressor which is located inside the wet scrubber housing.

An apparatus of this kind will not require very much more space than the gas scrubber that is known per se, because the incorporated noise suppressor can be located in the central chamber, in through which the gas is usually conveyed in conventional gas scrubbers.

The reactive noise suppressor may to advantage have a wall towards the surrounding wet scrubber chamber, over which wall the hot pulsating exhaust gas sweeps.

Thus, there is obtained in a particularly advantageous manner a heating, preferably a slight overheating, of the exiting gas as a result of the heat exchange with the hot pulsating exhaust gas through the wall separating the noise suppressor from the wet scrubber chamber.

The reactive noise suppressor may advantageously be located centrally in the housing. Furthermore, the reactive noise suppressor may be surrounded by a jacket extending from around the gas inlet and forming an annular flow chamber around the reactive noise suppressor.

The reactive noise suppressor may be open towards the annular flow chamber formed by the jacket at the end of the noise suppressor facing away from the gas inlet, the other end of the noise suppressor, the outlet end, being connected to the wet scrubber chamber by means of transverse ducts which intersect the space within the jacket. Expediently,

the reactive noise suppressor may be designed as a tubular body, the passage of which is in the form of a venturi nozzle.

As mentioned, sea water may advantageously be used for the fluid injection in both the scrubber and the venturi nozzle. Of course, the washout of contaminants will mean that the contaminants flow out into the sea, but tests have shown that even in the case of stationary ships (in port), the resultant dilution in the surrounding sea water will be so effective that the pollution will be negligible.

Additional features of the invention will be set forth in the dependent claims.

The invention will now be explained with reference to the drawings, wherein:

Figure 1 is a purely schematic illustration of one possible embodiment of an apparatus according to the invention;
Figure 2 is a purely schematic illustration of a second possible embodiment of an apparatus according to the invention;
Figure 3 is a purely schematic illustration of yet another possible embodiment of an apparatus according to the invention;
Figure 4 shows a more detailed embodiment of an apparatus according to the invention, in the form of a central longitudinal section through the apparatus; and
Figure 5 shows a schematic embodiment of an apparatus according to the invention.

The apparatus shown in Fig. 1 includes a housing 1 having a gas inlet 2 and a gas outlet 3. The gas inlet 2 is connected to the outlet end 28 of a venturi nozzle 7, the inlet end of which is indicated by means of the reference numeral 27. The inlet end 27 of the venturi nozzle is connected to a non-illustrated diesel engine, i.e., the diesel engine discharge header. The gas outlet 3 runs into the open. Moreover, the housing 1 has a bottom pipe 20 for the drawing off wash water and the contaminants incorporated therein.

In the wet scrubber there are positioned filter packages 9, 10 through which the gas will pass on its way upwards in the scrubber.

In the scrubber housing 1, above the lower filter package 9, there is arranged a ring main 11 which through a pipe 13 is supplied with low-pressure sea water which is sprayed out as indicated towards the filter package 9.

In the inlet portion 27 of the venturi nozzle 7 there is provided a ring main 12 having nozzles which are supplied with high-pressure sea water through the indicated pipe 25. High-pressure sea water can be passed out through the pipe 25 and the ring main 12 and the nozzles therein, and into the venturi nozzle 7, in the direction of the venturi nozzle outlet 28.

Uppermost in the wet scrubber, there is a conical tapering funnel 29. The funnel wall forms one of the walls of a Helmholtz resonator chamber 21. The openings from the gas outlet 3 and into the resonator chamber 21 are indicated by means of the reference numeral 22. After the Helmholtz resonator 21 there follows a so-called Lambda-1/4 resonator 26.

It is a well-known fact that a Helmholtz resonator is a resonator system wherein acoustic energy is drawn out of a gas flow when the sound waves are reflected against the noise source at a certain resonance frequency. A Lambda-1/4 resonator, as is well-known, is a resonance system which draws out acoustic energy at certain resonance frequencies in a way similar to the Helmholtz resonator. The attenuation produced will be a maximum for the frequency at which the length of the resonator chamber is a 1/4 of the sound wave length. Inside the wet scrubber housing, there is an oblique wall 30 opposite the inlet 2 which is instrumental in facilitating the flow of the gas upwards through the scrubber.

The apparatus shown in Fig. 2 includes a housing 1 having a gas inlet 2 and a gas outlet 3. The gas inlet 2 is connected to a non-illustrated diesel engine, i.e., the diesel engine discharge header. The gas outlet 3 runs out into the open. Moreover, the housing has a bottom pipe 4, for drawing off the wash water with contaminants incorporated therein.

A noise suppressor 5 is located centrally in the housing 1. The noise suppressor 5 includes a noise suppressor housing 6, the interior of which is connected to the gas inlet 2. Inside the noise suppressor housing 6 there is provided a venturi nozzle 7. The pulsating exhaust gas from the diesel engine flows in through the gas inlet 2 into the housing 6 and through the venturi nozzle 7 and out through an opening 8 in the bottom of the housing 6. This opening 8 runs into the chamber in the housing 1, where around the noise suppressor housing 6 there are placed filter packages 9, 10, which the gas passes on its way upwards in the annular chamber between the housing 1 and the housing 6 and up through the gas outlet 3.

In the annular chamber there is provided a ring main 11 with ejection nozzles for the ejection of sea water in countercurrent to the upward flowing gas. Similarly, one or more injection nozzles 12 are provided in the inlet of the nozzle 7. Sea water is supplied to the ring main or the nozzles 11 and the nozzles 12 by 13.

The apparatus in Fig. 2 functions in the following way:
Exhaust gas flows in through the gas inlet 2 and is noise-suppressed in the noise suppressor 5, where the pulsations in the gas are smoothed out, the gas first being accelerated in the nozzle 7 and then expanding and exiting through the opening 8 and into the surrounding gas scrubber. Sea water is injected in through the nozzle or nozzles 12 to enable particle separation and washout to take place in the venturi nozzle 7. The gas flows up through the filter packages 9, 10 and is scrubbed in countercurrent with the aid of sea water injected in through nozzles in the ring main 11. Contaminants, primarily soot particles and sulphur dioxide, are washed out and collect together with the wash water in the bottom of the housing 1, where they can be drawn off through the bottom pipe 4.

The exhaust gas which enters through the gas inlet 2 will sweep across the wall of the noise suppressor 5 and will thus heat the gas which flows into the annular chamber, thereby obtaining the desired heating and drying of the gas, which exits through the gas outlet 3.

The embodiment in Fig. 3 differs from that in Fig. 2 in that the noise suppressor 5 is open at the upper end thereof and is surrounded by a jacket 12 which is in communication with the gas inlet 2, which in this case is located in the bottom of the housing 1. The outlet opening 8 of the noise suppressor 5 is connected to the annular chamber between the housing 1 and the jacket 14 by means of a plurality of radial ducts (two are shown). The apparatus in Fig. 3 functions in essence like the apparatus in Fig. 2. The only difference is that the incoming gas, flowing through the gas inlet 2, now flows upwards in the jacket 14, along and around the noise suppressor 5 and then radially inwards and down through the noise suppressor 5 and the venturi nozzle 7 provided therein. From the opening 8 the gas flows through the radial tubes or ducts 15, 16 into the annular chamber between the housing 1 and the jacket 14. In this case too, the hot pulsating exhaust gas is instrumental in heating the gas in the surrounding scrubber, which gas exits through the gas outlet 3. As in Fig. 2, sea water is injected in though the conduit 15, the nozzle 12 and the ring main or nozzles 11.

A preferred, practical embodiment of the apparatus according to the invention is shown in Fig. 4. It has the same fundamental structure as the apparatus illustrated in Fig. 3. The same reference numerals have therefore been used for corresponding components.

The elements which recur are the housing 1, the centrally located jacket 14, the noise suppressor 5 placed therein, the filter packages 9, 10, the ring main 11 and the nozzles 12, here incidentally in the form of a small ring main, and the radial ducts 15, 16 (only two ducts are shown, but a greater number of radial ducts, e.g., four, may advantageously be provided).

The gas enters through the gas inlet 2 and exits through the gas outlet 3. The gas flow is indicated by the arrows, as in Fig. 3.

One practical difference is the design of the noise suppressor 5, inasmuch as the venturi nozzle 7 in Fig. 4 is designed so as to constitute a more integral part of the noise suppressor 5, which in Fig. 4 has more of the form of a tubular body with a nozzle passage. An inlet cone 17 is provided in the gas inlet 2, and similarly an outlet cone 18 is provided at the gas outlet 3. Likewise, an outlet cone 18 is provided at the gas outlet 8 from the nozzle 7.

As in Fig. 3, spent wash water with incorporated contaminants is drawn off through a bottom pipe 20.

Another especially preferred practical embodiment of the invention is shown in Fig. 5. This embodiment has a structure which in principle resembles the apparatus shown in Fig. 2. Here too, the same reference numerals are therefore used for corresponding components.

Recurring elements include the housing 1, the noise suppressor 5 located therein, the filter packages 9 and 10, the ring main 11 and the nozzles 12, here incidentally in the form of a ring main, which in this case are supplied with sea water under high pressure, and a bottom pipe 4, here sideways-oriented, for drawing off the wash water and the contaminants incorporated therein.

In Fig. 5 exhaust gas is passed in through the gas inlet 2 and into the noise suppressor which here has the form of a venturi nozzle 7. The gas flow is indicated by the arrows.

Thus, the gas flows from the venturi nozzle 7 up into the housing 1 and through the filter packages 9, 10 and at the top through the gas outlet 3.

For enhanced noise suppression, a resonator chamber 21 is provided in the apparatus in Fig. 5, obtained by extending the housing 1 wall around the outlet 3. In the outlet 3 there are openings 22 through which the sound will exit and enter the resonator chamber 21. An annular partition wall 23 is provided in the resonator chamber 21 opposite the openings 22.

Patent claims

1.
An apparatus for reducing contaminants in a pulsating exhaust gas, particularly diesel exhaust, on board ships, which apparatus comprises a wet scrubber, which includes a chamber in a housing (1) having a gas inlet (2) and a gas outlet (3), a fluid injection device (11, 13) and gas filters (9, 10) in the chamber, characterised in that a venturi nozzle (7), having a nozzle inlet (27) and a nozzle outlet (28), is connected by means of its nozzle outlet (28) to the gas inlet (2) of the wet scrubber.

2.
An apparatus according to claim 1, characterised in that in the nozzle inlet (27) there is provided a fluid injection device (12, 25).

3.
An apparatus according to claim 2, characterised in that the fluid injection means (12) in the nozzle inlet (27) is adapted for injecting a fluid in the direction of the nozzle outlet (28).

4.
An apparatus according to claim 2 or 3, characterised in that the fluid injection device (12, 25) in the nozzle inlet (27) is a high-pressure sea water device.

5.
An apparatus according to one of the preceding claims, characterised in that the fluid injection device (11, 13) in the wet scrubber chamber (1) is a low-pressure sea water device.

6.
An apparatus according to one of the preceding claims, characterised in that the wet scrubber is a vertical scrubber having a bottom gas inlet (2) and that the venturi nozzle (7) connected thereto is substantially horizontal.

7.
An apparatus according to claim 6, characterised in that the substantially horizontal venturi nozzle (7) opens out sideways in the wet scrubber's bottom, likewise sideways oriented gas inlet (2).

8.
An apparatus according to one of the preceding claims, characterised in that the wet scrubber gas outlet (3) is connected to one or more resonator chambers (21, 26).

9.
An apparatus according to claim 8, characterised in that at least one of the resonator chambers (21) is in the form of a Helmholtz resonator chamber.

10. 10.
An apparatus according to claim 8 or 9, characterised in that at least one resonator chamber is in the form of a Lambda-1/4 resonator (26).

11.
An apparatus according to claim 8, 9 or 10, characterised in that around the gas outlet (3) of the scrubber there are successively arranged a Helmholtz resonator chamber (21) and a Lambda-1/4 resonator chamber (26).

12.
An apparatus according to one of claims 8 to 11, characterised in that the chamber in the scrubber housing (1) has a conical upward tapering portion (29) which forms a wall in a resonator chamber (21).

13.
An apparatus according to one of the preceding claims, characterised in that the venturi nozzle (7) forms a part of a reactive noise suppressor (5) which is located inside the wet scrubber housing (1).

14.
An apparatus according to claim 13, characterised in that the reactive noise suppressor (5) has a wall (5, 14) towards the surrounding wet scrubber chamber, over which wall (5, 14) the hot pulsating exhaust gas sweeps.

15.
An apparatus according to claim 14, characterised in that the reactive noise suppressor (5) is located centrally in the housing (1).

16.

An apparatus according to claim 14 or 15, characterised in that the reactive noise suppressor (5) is surrounded by a jacket (4) extending from around the gas inlet and forming a flow chamber around the reactive noise suppressor (15).

17.

An apparatus according to claim 16, characterised in that the reactive noise suppressor (5) is open towards the flow chamber formed by the jacket (14) at the end of the noise suppressor (5) facing away from the gas inlet (2), the other end of the noise suppressor, the outlet end, being connected to the scrubber chamber by means of transverse ducts (15, 16) which intersect the chamber within the jacket (14).

18.

An apparatus according to one of preceding claims 13-17, characterised in that the reactive noise suppressor (5) is in the form of a tubular body, the passage of which is in the form of a venturi nozzle (7).

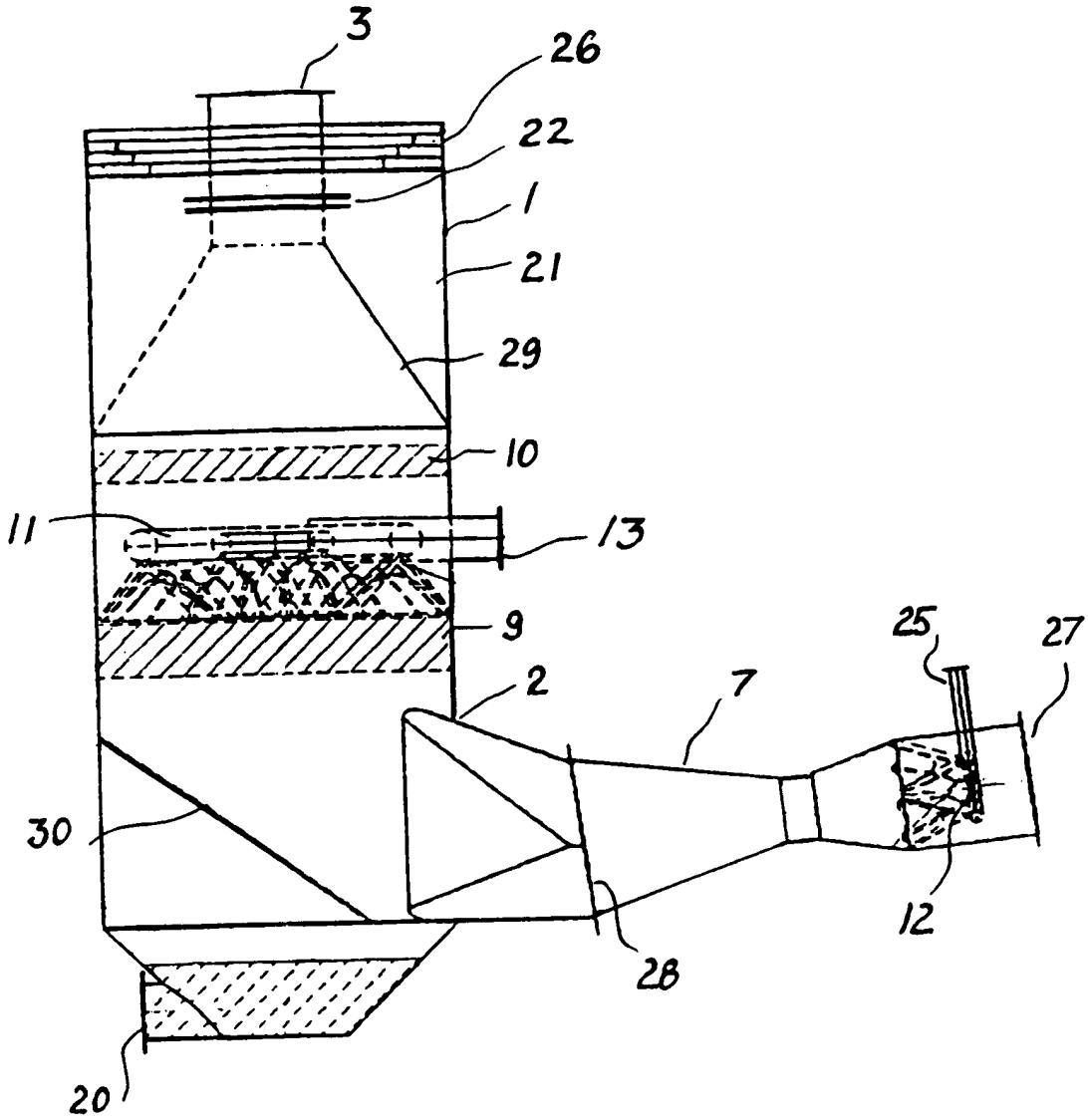

Fig. 1

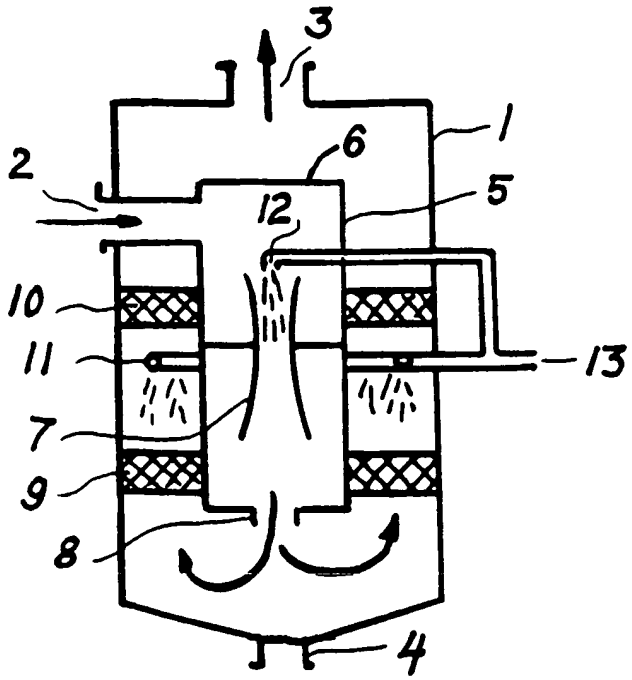

Fig. 2

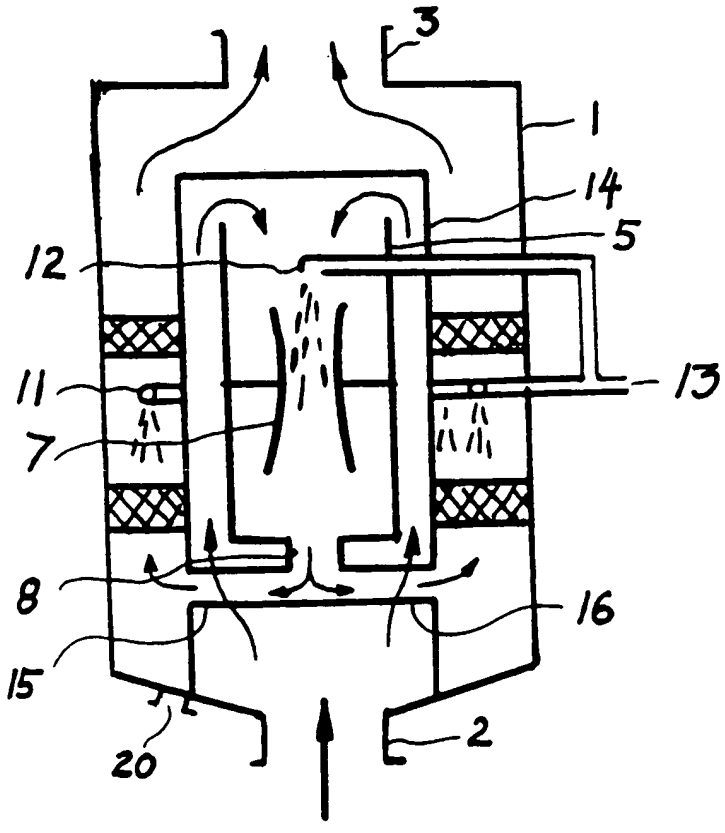

Fig. 3

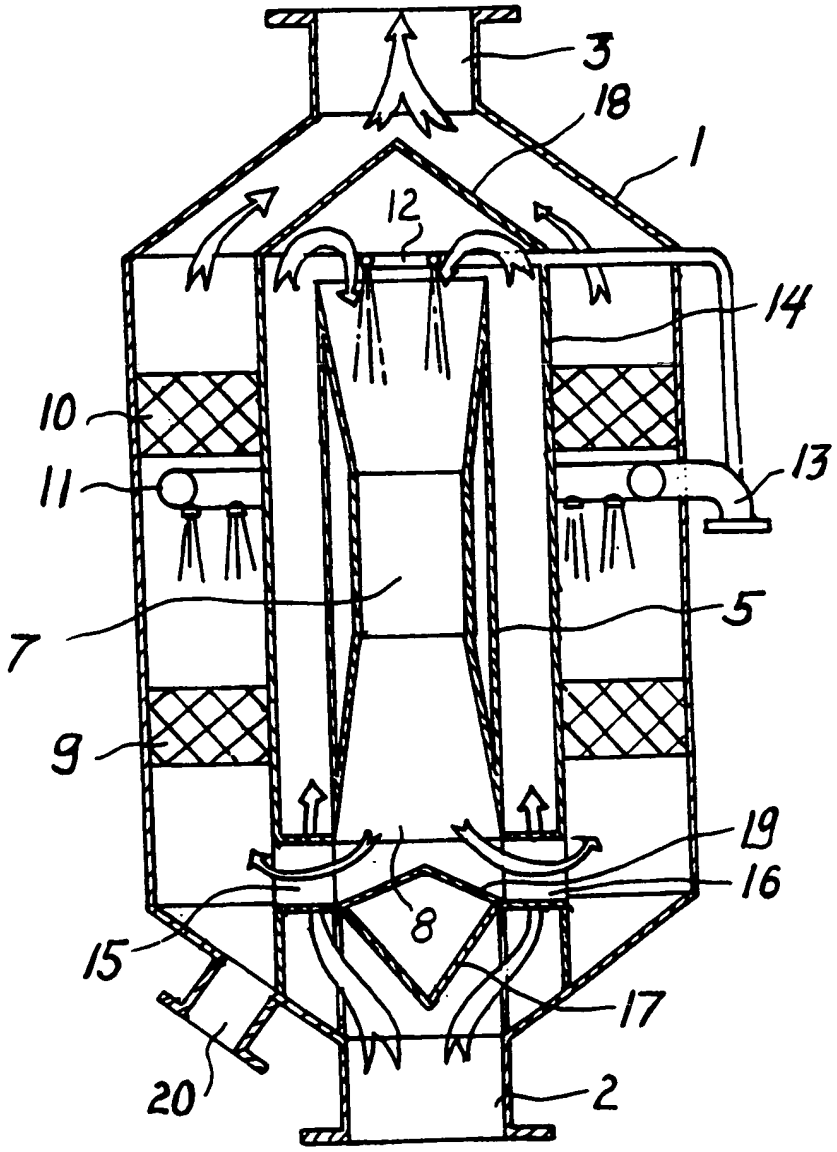

Fig. 4

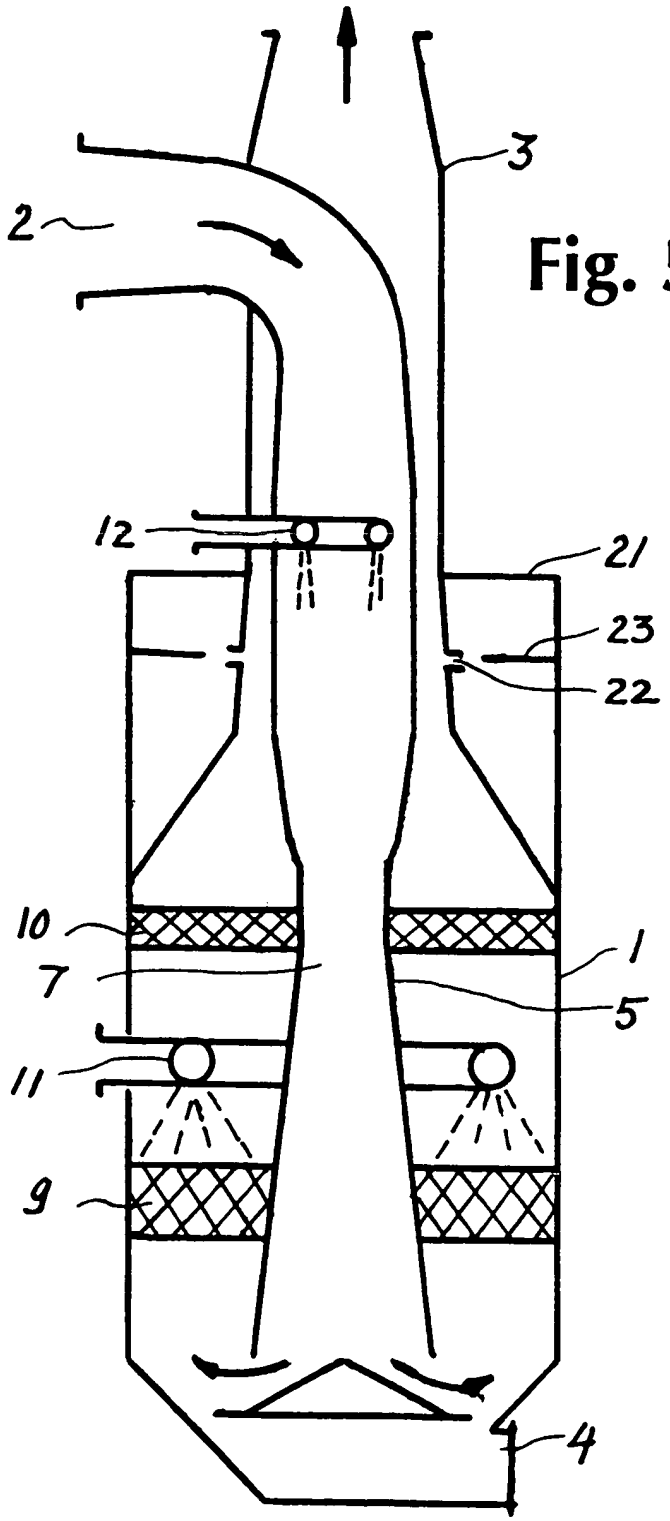

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 98/00067

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B01D 47/10, F01N 3/04, F01N 1/02
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: B01D, F01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3647394 US (JOSEPH R. WETCH ET AL), 7 March 1972 (07.03.72), column 2, line 5 - line 75, abstract, figures	1-7,13-18
Y	--	8-12
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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9 October 1998	13-10-1998
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INTERNATIONAL SEARCH REPORT

International application No.
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT

Information on patent family members

27/07/98

International application No.
PCT/NO 98/00067

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